

GLAST Large Area Telescope Calorimeter Subsystem 6.0 Mechanical Subsystem

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CDR Outline

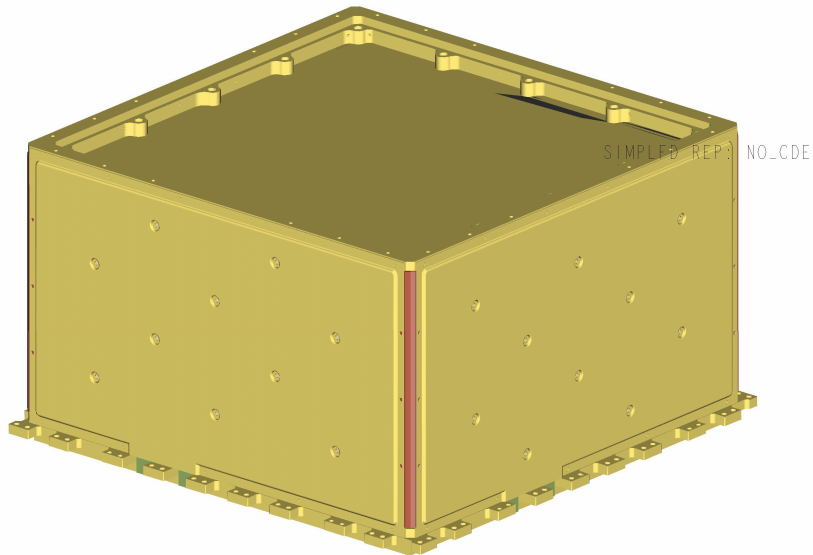
□ CAL Mechanical Subsystem

- **Subsystem Overview** **Paul Dizon**
- **Mechanical Design and Analysis** **Oscar Ferreira**
- **Thermal Design and Analysis** **Pierre Prat**
- **Manufacturing of Flight Modules** **Paul Dizon**
- **Summary** **Paul Dizon**





CAL Design Overview



Key Parameters

Dimensions	Max Length & Width	363.0 x 363.0 mm ²
	Min Length & Width	382.5 x 382.5 mm ²
Height		221.8 mm
Mass	Structure	9.6 kg
	Electronics	1.7 kg
	CDE	75.7 kg
	Total	87.0 kg
First Mode Frequency		>150 Hz
Max Deflection	Static Load	0.3 mm
	Random Vibration	0.3 mm RMS





CAL Design Overview

- ❑ **Pre-Electronics Module Assembly**
 - **PEM Mechanical Structure**
 - **Carbon Fiber Structure**
 - **Aluminum Base Plate and Top Frame**
 - **Crystal Detector Elements (CDE) - 96 Units**
 - **Close-Out Plates**

- ❑ **CAL Module Assembly**
 - **PEM Assembly**
 - **AFEE Cards**
 - **Side Panels**
 - **TEM Stand-Off**
 - **TEM Harness and Associated Brackets**



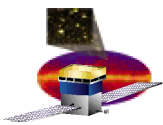


CAL Design Overview

□ Engineering Challenges

- **Maximize Packaging Volume for AFEE While Minimizing Effective Detector Gaps Between Adjacent CAL Modules**
- **Ensure Structural Stiffness of the CAL Modules without Relying on the Mechanical Properties of the CsI Crystal Logs**
- **Secure CsI Crystal Logs for Launch Loads without Constraining them During Thermal Expansion**

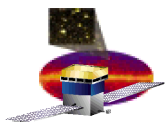




Derived Requirements

Document Title	Document Number	Status
Mechanical Systems Interface Definition Drawing, CAL - LAT Interface	LAT-DS-00233	Released
LAT Contamination Control Plan	LAT-MD-00404-02	Released
Interface Control Document between the Calorimeter Subsystem and LAT Instrument	LAT-SS-00238-04	Released
CAL Mechanical Structures Specification	LAT-SS-00241-03	Released
LAT Environmental Specification	LAT-SS-00778-01-D8	In signoff

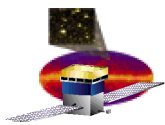




Compliance Matrix

Parameter	Requirement	Compliance	Comments
Physical Interfaces & Clearance <ul style="list-style-type: none"> - Dimensions & Tolerances - Surface Condition of Tabs - Static Stay-Clear Dimensions - Dynamic Stay-Clear Dimensions <ul style="list-style-type: none"> - Lateral - Vertical 	per IDD - LAT-DS-00233 per LAT-SS-00238 0.50 mm MAX 0.50 mm MAX	YES YES YES YES YES	Measured on EM Measured on EM Measured on EM Verified on VM2 (<0.3 mm) Verified on VM2 (<0.3 mm)
Base Plate Requirements <ul style="list-style-type: none"> - Stiffness - CTE 	per LAT-SS-00238 Equivalent to 8 mm Al Plate CTE = 21-25E-6 m/m/deg C	YES YES	Equivalent to 8 mm Thickness (Plus Margin) Aluminum Plate
Mass Properties <ul style="list-style-type: none"> - Mass - Center of Gravity 	per LAT-SS-00238 90 kg Max Lateral Offset +/- 10 mm Max Z CG Position = 116 mm	YES YES YES	Measured on EM (approx 86 kg) Analysis Shows within +/- 1 mm Analysis Shows Zcg = 87.5 mm from CAL-Grid Interface
Structural Load Environment <ul style="list-style-type: none"> - Static-Equivalent Accelerations - Random Vibration - Interface Limit Loads - Interface Distortion Limit Loads - TEM Interface Loads 	per LAT-SS-00238/LAT-SS-00778 Lateral = +/- 6.0 g Axial = +6.8/-1.8 g 4373 N max across tab 0.25 mm max distortion Tension = 3750 N Compression = 2625 N Shear = 1288 N Bending Moment = 19.3 Nm	YES YES YES YES	Verified on VM2. To be Re-verified on EM (Analysis Shows Positive Margins) Verified on VM2. To be Re-verified on EM (Analysis Shows Positive Margins) Verified on VM2. To be Re-verified on EM (Analysis Shows Positive Margins) To be Verified on EM (Analysis Shows Positive Margin) Analysis Shows Positive Margin To be Verified on EM (Analysis Shows Positive Margin)

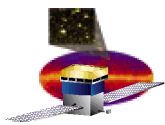




Compliance Matrix - Continued

Parameter	Requirement	Compliance	Comments
Thermal Environment	per LAT-SS-00238/LAT-SS-00778		
- CAL-Grid Conductance	>0.03 W/cm ² deg C	YES	Analysis uses 0.25 W/cm ² deg C. Analysis to be updated following TVAC Testing
- CAL-TEM/PS Contact Conductance	0.1 W/deg C	YES	Analysis used 0.1 W/deg C. Analysis to be updated following TVAC Testing
- Operating Temperature	+25/-15 deg C	YES	Analysis shows CAL Meets Temperature Requirements
- Survival Temperature	+50/-30 deg C	YES	Analysis shows CAL Meets Temperature Requirements
First Natural Frequency	per LAT-SS-00238		
	> 50 Hz	YES	Verified on VM2 and by Analysis (>150 Hz). To be Re-verified on EM
Venting	per LAT-SS-00238/LAT-SS-00778	YES	Analysis Shows Positive Margin
Preserve Safety of CDEs	No Light Yield Change	YES	Verified on VM2
Contamination/Particulates	per LAT-SS-00238	YES	All Particulates Generated from Fracture-Sensitive Materials will be Contained within the Stay-Clear Volume of the CAL
	per LAT-MD-00404	YES	All materials approved for flight Structural cleanliness addressed during assembly Bake out of all composite and polymer materials



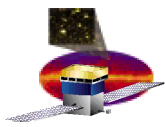


Changes Since PDR

- ❑ **AFEE Card Packaging Volume Resizing**
 - **AFEE Card Redesign Resulted in Required Increase in Packaging Volume. Increased Packaging Volume by:**
 - **Shortening Length of CDE**
 - **Decreasing the Distance Between Opposing Close-Out Plates by Modifying Base Plate and Top Frame Interface Dimensions**

- ❑ **Close-Out Plate Redesign**
 - **Incorporated Stiffeners to Minimize Deflection**
 - **Openings for Electrical Interconnects between CDE PDA and AFEE Redesigned due to Removal Flex Cable from Design:**
 - **Geometry of Openings for Electrical Interconnects Modified to Accommodate New Design**
 - **Position of Openings for Electrical Interconnects Changed to Reflect New Position of AFEE Components**

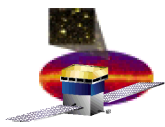




Changes Since PDR - Continued

- ❑ **Base Plate Modifications Requested by SLAC**
 - **Modifications were Required to Reduce Stiffness in order to Decrease Bolt Loads at the Tab-LAT Grid Interface**
 - **Increase Tab Length**
 - **Decrease Tab Thickness**
 - **Maximize Friction Characteristics of the Bolted Joint**
 - **Reduce Outer Radius of Tab Corners**
 - **Remove Chamfer of Upper and Lower Surface of Tab**
 - **Remove Surface Treatment on Upper and Lower Surface of Tab**
- ❑ **Additional Base Plate Modifications**
 - **TEM Interface**
 - **Flex-Mount changed to Hard-Mount Interface**
 - **TEM Cable Bracket Interface**





Changes Since PDR - Continued

- ❑ **Improvement of Cure Process for Composite Structure**
 - **Improved Curing Process Has Better Pressure Control**
 - Vacuum Bagging
 - Autoclave
 - **Tooling Redesigned to Accommodate New Curing Process**
- ❑ **CDE Interface**
 - **Bumper Frame Redesign**
 - **Added End Caps to Eliminate PDA Clearance Issues with the Original Bumper Design**
- ❑ **Assembly Tooling and Procedures**
 - **Minor Changes due to Change from Flex Cable to Twisted Wire Pairs for PDA Electrical Interconnects**





Status of PDR RFAs

- ❑ **No RFAs Assigned at the PDR**



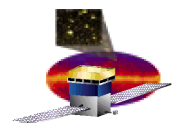


Schedule

□ Top Level Milestones

- **Completed EM PEM Assembly** **10 Feb 2003**
- **Complete EM CAL Module Assembly** **31 Mar 2003**
- **Start EM Structural Environmental Testing** **22 Apr 2003**
- **Production of SM CAL Test Structure** **09 Apr 2003**
- **Start EM Thermal Vacuum Testing** **06 May 2003**
- **Production of SFM CAL Test Structure** **30 June 2003**
- **Delivery of Flight PEM Structures** **24 Jul 2003 thru Mar 2004**



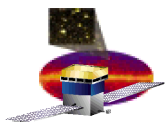


CAL Subsystem Mass

Mechanical Structure Mass for Each CAL Module

Project Phase		Pre-CDR		Subsystem :		CAL Module		Date of latest Update :		24-Feb-03			
List No	Part or Dwg No.	Component Name/Desc.	Quantity	MASS		Estimation Method (PARA, CALC, or MEAS)	Total	(Kg)	Development Class 2, or 3)	Calculated Contingency Recommendation (ANSI/AIAA-G-020-1992)	X-Axis Center of Mass (mm)	Y-Axis Center of Mass (mm)	Z-Axis Center of Mass (mm)
				Mass (Kg)									
1	LAT-DS-01115-01	CsI Crystal	96	0.773	MEAS		74.241	3		2%	-	-	-146.37
2		PIN Photodiode	192	0.0016	MEAS		0.307	3		2%	-	-	-146.37
3		Twisted Wire Pair	192	0.0001	CALC		0.019	2		20%	-	-	-146.37
4		Optical Bond Material	192	0.0002	MEAS		0.038	3		2%	-	-	-146.37
4		Optical Reflective Wrap	96	0.0033	MEAS		0.317	3		2%	-	-	-146.37
5		End Cap	192	0.0006	MEAS		0.115	2		20%	-	-	-146.37
6										-			
7		Printed Circuit Board (AFEE)	4	0.360	CALC		1.440	2		20%	-	-	-134.16
7		AFEE-TEM Cable	4	0.050	CALC		0.200	1		25%	-	-	-256.20
8		AFEE-TEM Cable Bracket	4	0.005	PARA		0.020	1		25%	-	-	-256.20
9										-			
10	LAT-DS-00918-01	Composite Structure	1	2.651	MEAS		2.651	2		20%	-	-	-147.20
10	LAT-DS-00927-01	EMI Shield	1	0.029	MEAS		0.029	3		2%	-	-	-45.40
11	LAT-DS-01234-01	Insert, Side	40	0.001	MEAS		0.057	3		2%	-	-	-147.20
12	LAT-DS-00928-01	Insert, Top Composite	16	0.001	MEAS		0.023	3		2%	-	-	-147.20
13	LAT-DS-00929-01	Insert, Bottom Composite	25	0.005	MEAS		0.114	3		2%	-	-	-147.20
14										-			
15	LAT-DS-00917-01	Top Frame	1	0.625	MEAS		0.625	3		2%	-	-	-36.45
16	LAT-DS-00919-01	Base Plate	1	3.190	PARA		3.190	3		2%	-	-	-238.17
17	LAT-DS-00920-01	Close-Out Plate X Assembly	2	0.330	MEAS		0.660	3		2%	-	-	-133.23
18	LAT-DS-00921-01	Close-Out Plate Y Assembly	2	0.330	MEAS		0.660	3		2%	-	-	-133.23
19	LAT-DS-00923-01	Side Panel X	2	0.146	MEAS		0.292	3		2%	-	-	-132.78
20	LAT-DS-00924-01	Side Panel Y	2	0.146	MEAS		0.292	3		2%	-	-	-132.78
21										-			
22	LAT-DS-00922-01	Nut	40	0.0016	MEAS		0.064	3		2%	-	-	-147.20
23										-	-	-	
24	LAT-DS-00925-01	Bumper (Elastomer)	192	0.0004	MEAS		0.077	2		20%	-	-	-146.37
25	LAT-DS-00925-01	Bumper Frame (Delrin)	192	0.0004	MEAS		0.077	2		20%	-	-	-146.37
26	LAT-DS-00926-01	Spacer (Omit from Current Design)			PARA					-			
27		Elastomeric Cords	384	0.0002	MEAS		0.077	2		20%	-	-	-146.37
28													
29		Fasteners	1	0.300	MEAS		0.300	3		2%	-	-	-146.37
30													
31		Miscellaneous	1	0.100	PARA		0.100	1		25%	-	-	-146.37
32										-			
Total for 1 Module				Total Mass		85.985				3% Total Mass Contingency	0.00	0.00	-148.75
				Total PARA Mass		3.310		3.8%			Center of Mass(x,y,z) for this Module		
				Total CALC Mass		1.659		1.9%					
				Total MEAS Mass		81.016		94.2%					
						85.985		100.0%					
Total for 16 Modules				Total Mass		1375.759				3% Total Mass Contingency	0.00	0.00	-148.75
				Total PARA Mass		52.960		3.8%			Center of Mass(x,y,z) for this Module		
				Total CALC Mass		26.547		1.9%					
				Total MEAS Mass		1296.252		94.2%					
						1375.759		100.0%					





Mechanical Design Status

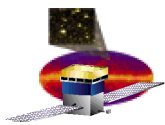
❑ Mechanical Design

– Base Plate	100	%Complete
– Top Frame	100	%Complete
– EMI Shield	100	%Complete
– Composite Structure	100	%Complete
– Composite Structure Flt Tooling	75	% Complete
– Bumper Frame/End-Cap Design	100	%Complete
– Close-Out Plate Assembly	95	% Complete
– Side Panels	100	%Complete

❑ Drawings **90 % Complete**

❑ Specifications/Procedures **75 % Complete**





CAL Module Fabrication Drawings

DRAWING	DRAWING NUMBER
CALORIMETER ASSEMBLIES	
EM	LAT-DS-00916-02
Pre-Electronics Module (PEM) Assembly	LAT-DS-01224-01
PEM Mechanical Structure Shipping Configuration	LAT-DS-01228-01
PEM Mechanical Structure	LAT-DS-01231-01
MECHANICAL STRUCTURE PIECE PARTS	
Top Frame	LAT-DS-00917-01
Composite Structure	LAT-DS-00918-02
Base Plate	LAT-DS-00919-04
Close Out Plate X	LAT-DS-00920-03
Close Out Plate Y	LAT-DS-00921-03
Nut	LAT-DS-00922-01
Side Panel X	LAT-DS-00923-02
Side Panel Y	LAT-DS-00924-02
Bumper Frame	LAT-DS-00925-02
Insert, Side	LAT-DS-00927-01
Insert, Top Composite	LAT-DS-00928-01
Insert, Bottom Composite	LAT-DS-00929-01
EMI Shield	LAT-DS-01234-01

